INTRODUCTION OF THE EFFECTIVE COUNTERMEASURE TO CURB PASSING SPEED IN ETC LANES

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ABSTRUCT

In Japan, ETC (Electronic Toll Collection System) utilization has increased dramatically since its introduction in July 2001 and the ETC utilization rate has been over 75%.
With the increase of ETC utilization, some ETC-equipped vehicles pass over ETC lanes at over 20 km per hour and car accidents in ETC lanes to vehicles stopping in ETC lanes have increased. To cope with this situation, the countermeasure to curb passing speed in ETC lanes has become the urgent issue.

On this research paper, we are going to introduce our trial to curb passing speed in ETC lanes and the effect of the trial. Our countermeasure is retarding a reaction of gate bars in ETC lane. This countermeasure intends to have drivers think that gate bars might not open, so drivers slow down in ETC lanes for a moment.

THE FEATURE OF JAPANESE ETC SYSTEM

OBE (ETC on-board equipment) has two or three modules. In the case of two modules, OBE consists of OBE itself and a credit card. We use ETC system inserting a credit card into OBE. In three modules case, OBE consists of OBE main body, an antenna and a credit card. In addition, there are four-module OBE with a speaker and OBE connected to a car navigation system that is popular in Japan. Anyway, the unique feature is that OBE is used being inserted a credit card. This means that, by using credit card to pay for expressway tolls, Japanese ETC gets nonstop passing at tollgates and certain collection of money possible at the same time.

OBE is fixed in a car. OBE comes to be active after being installed identification processing data (e.g. license plate number, vehicle classification, vehicle weight) of the car. This process is called setup operation. These processes get under way by professional ETC shops. Electric power is provided through an automobile battery.

Buy-out system for end users has been adopted. The average market price of OBE was around 15,000 yen (about $150) in 2009 and it costed around 5,000 yen (about $50) to cover setup operation and installation expense. End users had to pay around 20,000 yen (about $200) in total.

With ETC, perfect nonstop passing at both entrance and exit of tollgates is possible.

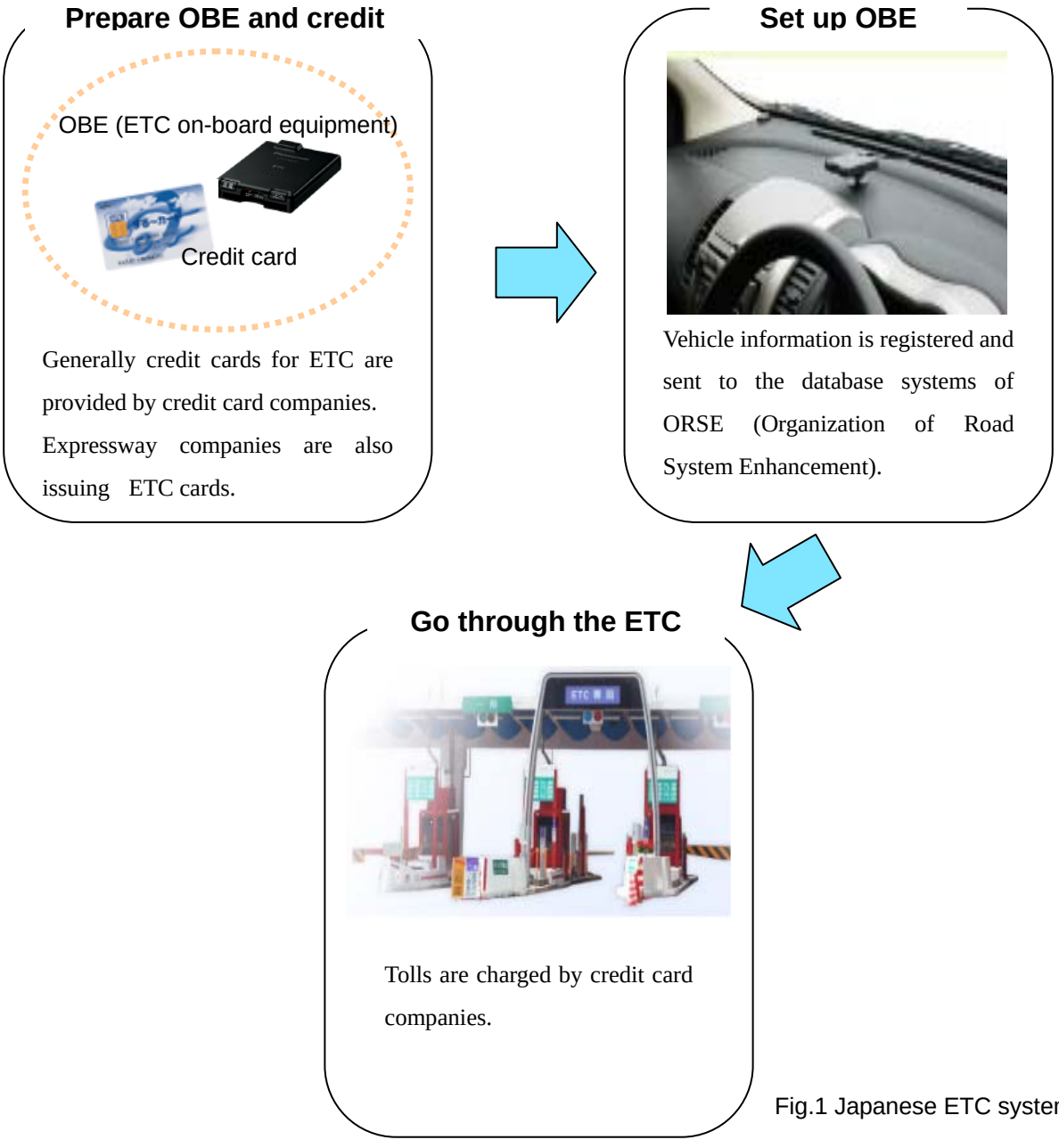

Fig.1 Japanese ETC system

PREVIOUS COUNTERMEASURES

In Japan, we have asked ETC-equipped vehicles to pass over ETC lanes at less than 20 km per hour. However, many ETC-equipped vehicles pass over ETC lanes at over 20 km per hour. To curb passing speed in ETC lanes, Nexco West (West Nippon Expressway Company Limited), as an expressway operator, has done various countermeasures (for instance, reminder on road surface), but has not gotten effective results.

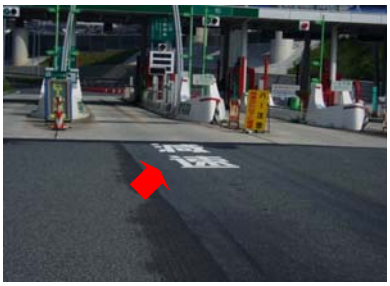

Fig.2 Remainder on road surface “Slow down”

Fig.3 Putting traffic cones

THE COUNTERMEASURE BY RETARDING A REACTION OF GATE BARS

Now it takes less than 0.5 seconds to finish opening gate bars after a vehicle detector recognizes an ETC-equipped vehicle. Therefore, an ETC-equipped vehicle can pass over in an ETC lane at 86 km per hour (almost 54 miles) without touching against gate bars.

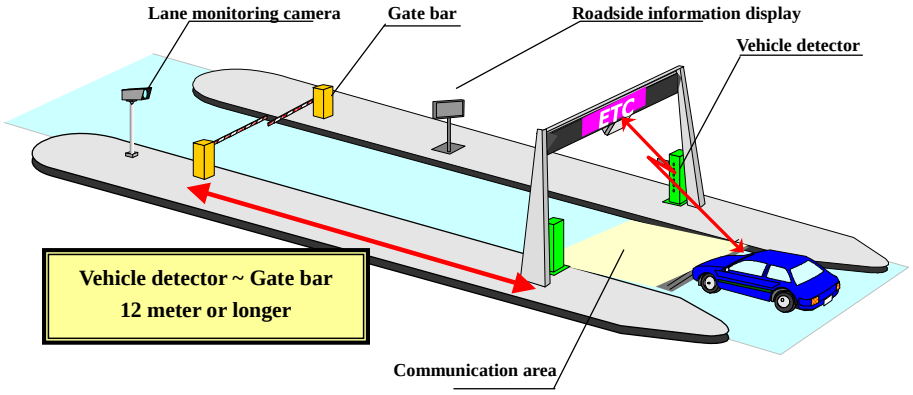

Fig.4 Image of ETC lane

We chose one tollgate (Himeji-nishi) and did field trial. We slowed down passing speed by giving another few tenths of seconds after an ETC-equipped vehicle is recognized.

Setting speed (at Himejinisi tollgate)

Vehicle detector – Starting control bar 14.6 m 0.5 s ⇒ Upper limit 105 km/h

0.4s delay

0.5 s + 0.4s ⇒ Upper limit 58 km/h

Public information

By retarding a reaction of gate bars in ETC lanes the countermeasure intends to have drivers think that gate bars might not open, so drivers slow down in ETC lanes for a moment.

However, Nexco West was concerned two possibilities. First, some vehicles passing over ETC lanes at relatively high velocities bump against gate bars. The upper limit decreased from 105 km to 58 km. This means that passing ETC lanes at over 58 km might not be able to pass ETC lanes without bumping after the introduction of the countermeasure. Another one is that some drivers would misunderstand that gate bars do not open and would stop their car at ETC lanes. This situation causes rear-end motor vehicle collusion. ETC can allow nonstop passing at tollgates, so drivers of following cars do not think that leading vehicles would stop in ETC lanes and bump against leading vehicles.

To get drivers know the countermeasure, Nexco West implemented public relations on radio listened only on expressways, displayed banners over crossing bridges, set LED indicators around Himeji-nishi tollgate, passed out flyers at rest areas and put guards around the tollgate.

LED indicator

Sign around ETC lane

Guard

Flyer

Banner

Fig.5 Public information procedures

Trial Result at Himeji-nishi

(1) Transition of average approaching speed

The average speed went down by over 3km/h, from 34.8km/h to 31.4km/h at an entrance and from 35.8km/h to 32.1km/h at an exit.

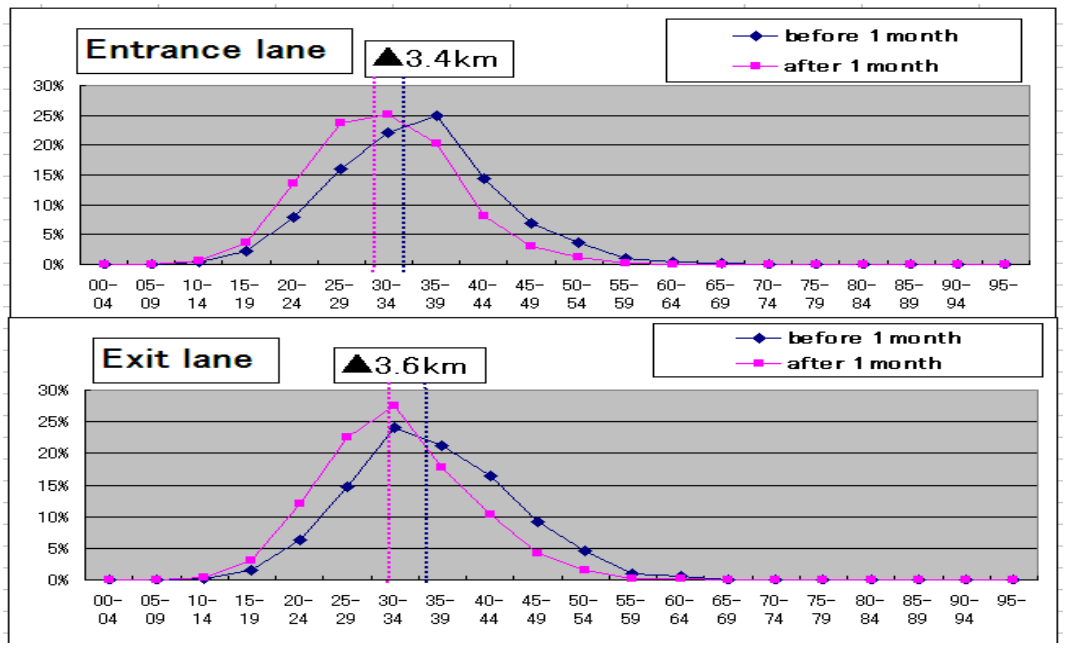

Fig.6 Transition of average approaching speed (at Himeji-nishi tollgate)

(2) Transition of high-speed vehicle

A vehicle passing over at over 40 km/h tends to cause more accidents against a stopping vehicle in ETC lanes. The portion of vehicles decreased from 26.3% to 12.8% at an entrance and decreased from 31.9% to 16.5% at an exit.

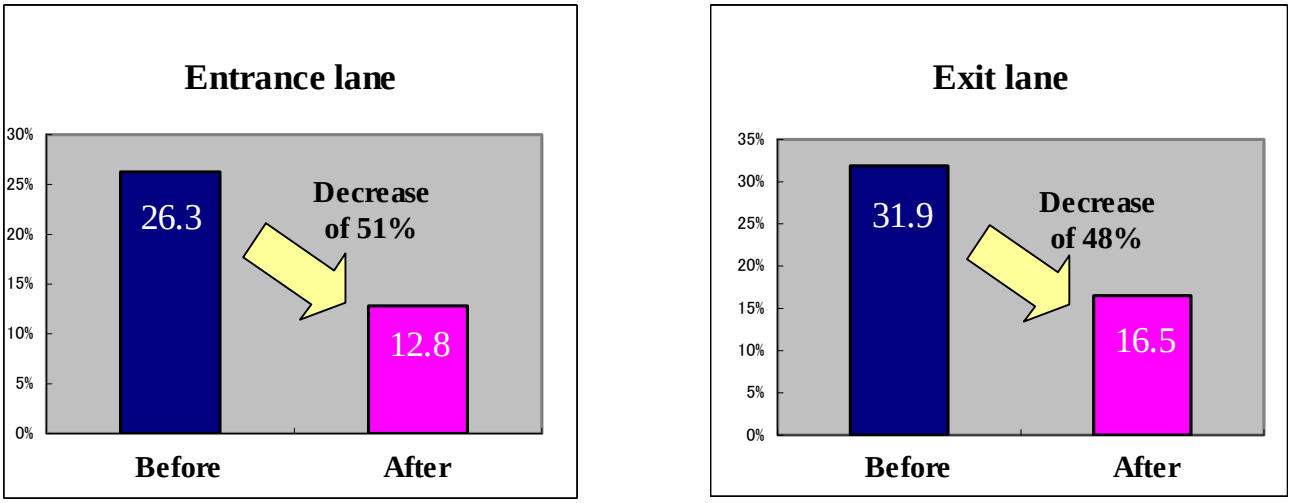

Fig.7 The rate of vehicles passing over at over 40 km/h

(3) Transition of minor collision with gate bars

The rate of minor collision with gates bar decreased from 0.0596% to 0.0437%.

The rate of minor collision with gate bars = Minor collision counts / Units passing ETC lane

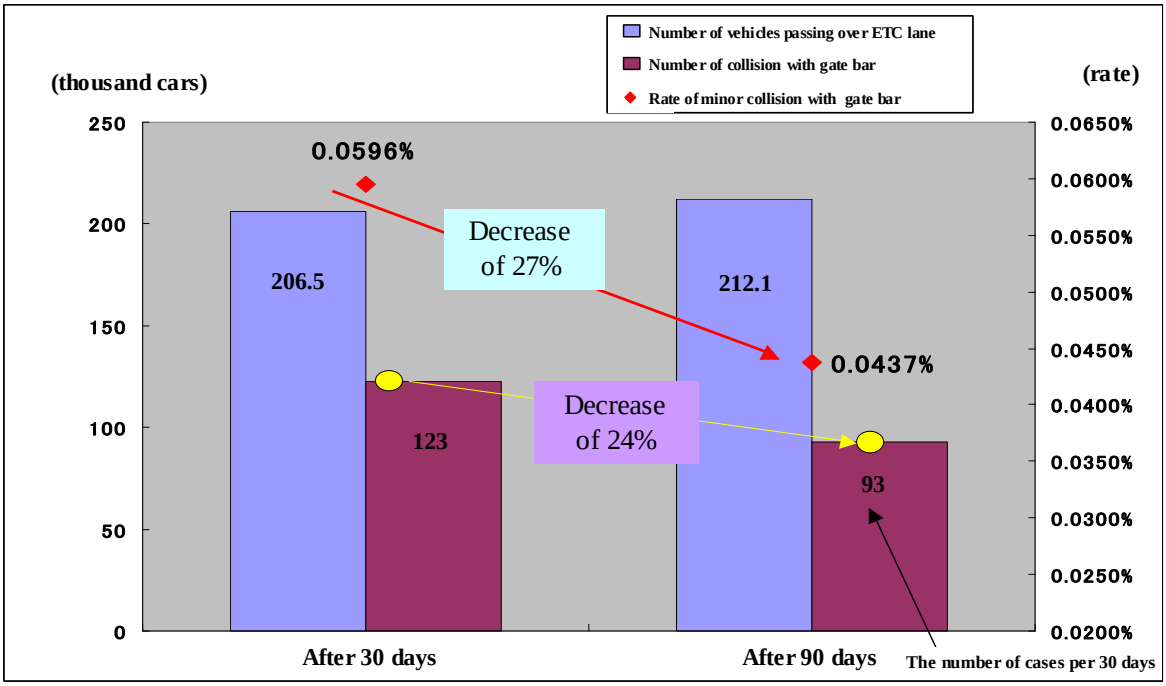

Fig.8 Transition of minor collision with bate bars

(4) Comprehensive evaluation

	Countermeasure			
	Road marking	**Traffic cone**	**Bump pavement**	**Retarding reaction of gate bar**
Contents	Marking "Slow Down" on road surface before ETC lane	Putting trafic cones before ETC lane to have ETC lane seen narrow	Setting bumps (around 5 mm) intermittently before ETC lane	Retarding reaction of gate bar intentionally and letting vehicles decrease velocities
Average speed	Quantitative outcome was not gotten.	Quantitative outcome was not gotten.	About 1 km/h decrease was observed.	About 3.5 km/h decrease was observed.
Car passing over 40 km	Quantitative outcome was not gotten.	Quantitative outcome was not gotten.	Quantitative outcome was not gotten.	Cars over 40 km/h decreased by about 50%.
Others			Transporters of precision machine complained about bump to Nexco.	Rate of bump agains gate bars decreased.

The above chart shows that retarding a reaction of gate bar is the most effective countermeasure to curb passing speed in ETC lanes. Therefore, Nexco West expanded the trial field and set the countermeasure by retarding a reaction of gate bars in 90 ETC lanes of all 41 tollgates under Shikoku regional bureau which is the smallest bureau of Nexco West.

Fig.9 Shikoku region

Result in Shikoku region

We are going to show the before-after analysis of the results one month later as following.

(1) Transition of average approaching speed

The average speed went down by 3.9km/h, from 34.6km/h to 30.7 km/h.

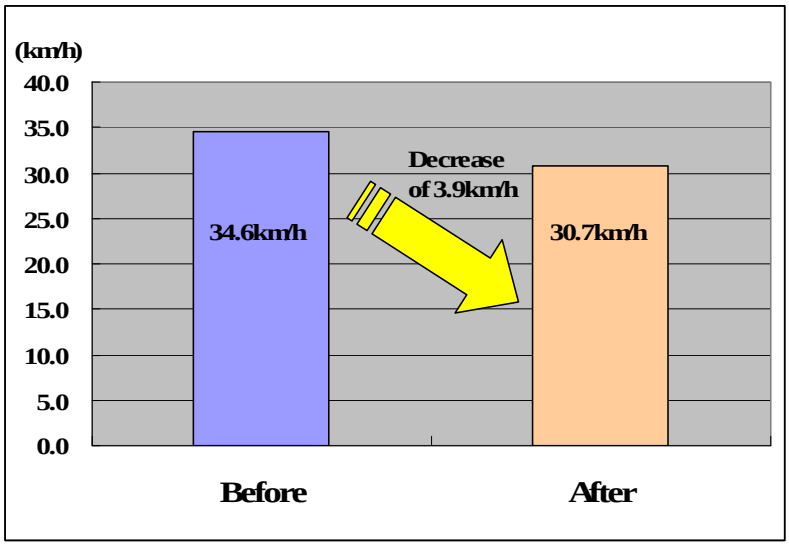

Fig.10 Transition of average approaching speed (at Shikoku region)

(2) Transition of high-speed vehicle

A vehicle passing over at over 40 km/h tends to cause more accidents against a stopping vehicle in ETC lanes. The portion of vehicles decreased from 25.5% to 8.8% at an entrance and an exit.

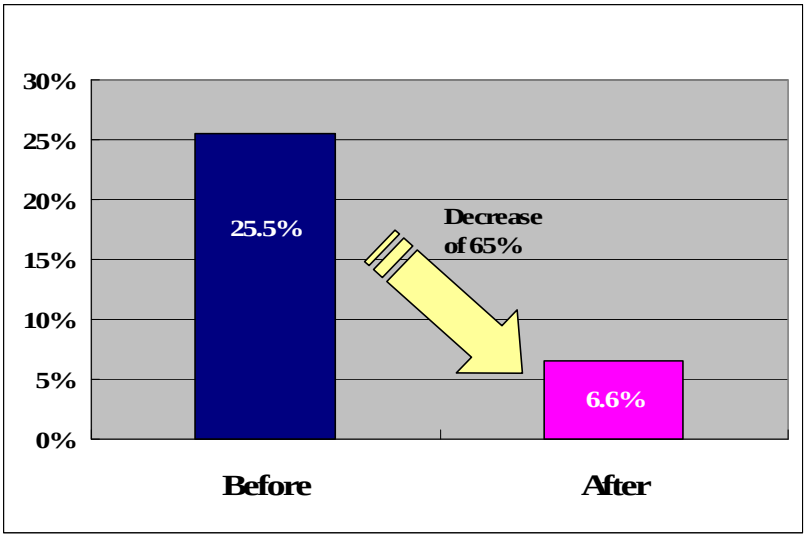

Fig.11 The rate of vehicles passing over at over 40 km/h

(3) Transition of minor collision with gate bar

The rate of minor collision with gate bars decreased from 0.0162% to 0.0123%.

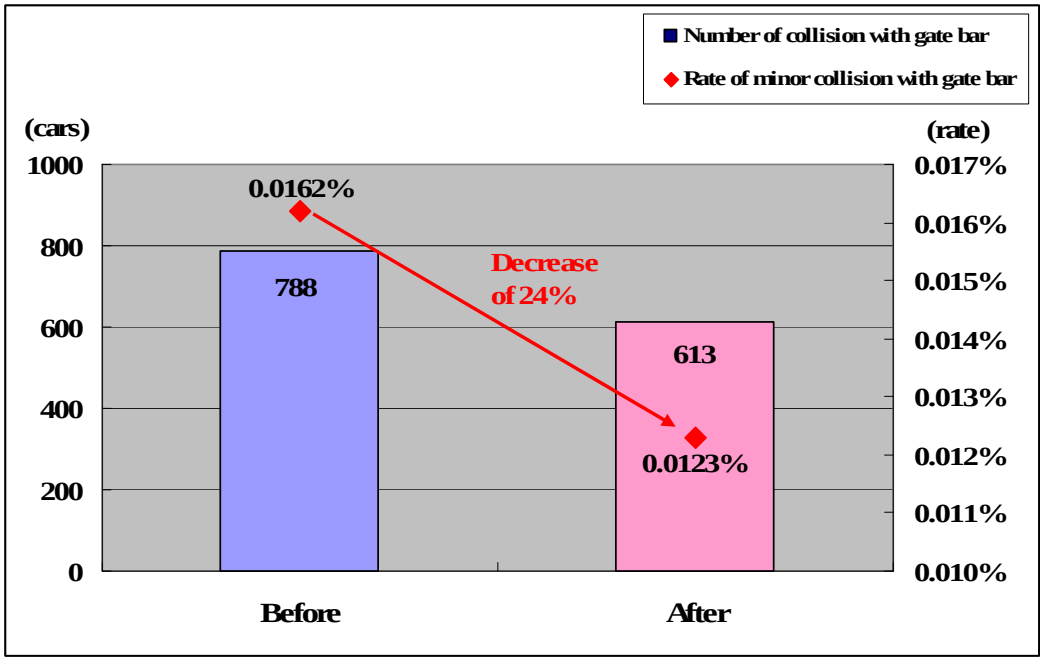

Fig.12 Transition of minor collision with bate bars

CONCLUSION

By retarding a reaction of gate bars in an ETC lane, we got good results from the trials at Himeji-nishi and in Shikoku region. Particularly, the portion of vehicles passing over at over 40 km/h decreased by about 50%. In addition, the rate of minor collision with gate bars decreased by about 15%. This shows that our countermeasure is effective to decrease minor collisions in ETC lanes.

Taking this trial result into consideration, Nexco West will deploy this countermeasure to all 358 tollgates in 2009.